LEACH Hierarchical Protocol Based on ACO and BCO

Rishu Singla[1], Er. Dinesh Kumar[2]

[1]*M.Tech CSE,*
GZS PTU Campus, Bathinda *(Pb)*
[1]rishusingla14@gmail.com

[2]*Assistant Professor,*
Department of CSE, GZS PTU Campus, Bathinda (Pb)
[2]dinesh.gzscetbti@gmail.com

Abstract: Wireless Sensor Networks (WSNs) consists of little nodes with sensing, calculation and wireless transportation capabilities. Numerous routing protocols have been particularly designed for WSNs where the throughput and energy consumption are the vital invent issues. LEACH protocol is one of the clustering routing protocols in wireless sensor networks that are able to deal out energy indulgence evenly all over the sensors. There are two stages of the protocol i.e. setup phase and steady phase. In this work, Matlab 7.0 version has been utilized for the simulation job. We first outline the design challenges for routing protocols in WSNs such as performance on the basis of throughput and energy consumption. Then the objective of the research work to build up the enhanced network algorithms those are for improvement in performance in large-scale systems. Design a code of behavior that can equally and proficiently distribute the energy consumption across all nodes. Then implement the Ant Colony Optimization algorithm and Bee Colony Algorithm in combination with Neural Network. The goal is to provide a new design method for optimizing energy consumption. Finally, we review the performance of ACO-Neural network and BCO-Neural network strategies based on performance metrics with a focus on realistic applications.

Keywords: ACO, BCO, LEACH Protocol, Neural Network, Wireless Sensor Network.

1. Introduction

The rising field of wireless sensor networks mingles sensing, working out, and announcement into a single miniature device. [1]These sensor nodes are speckled in an unattended atmosphere (i.e. sensing field) to sense the material world. The sensed information can be serened by a few sink nodes which have admittance to transportation networks like the Internet. The largely clear-cut purpose of wireless sensor network technology is to observe inaccessible environments for low frequency data tendency. A wireless sensor network system habitually contains sensor nodes, sink node and supervision node. A huge number of sensor nodes are arranged in the supervised area, constituting a network in the course of the way of self-organization. The data examined by sensor nodes is broadcast next to other nodes individually, that will achieve the sink node behind a multi-hop routing and at last attain the management node in the course of the wired (or) wireless Internet. The force, the capability of signal practice, storage ability and communication competence of sensor nodes are very inadequate. So, Heinzelman, pioneered a hierarchical clustering algorithm for sensor networks, called Low Energy Adaptive Clustering Hierarchy (LEACH) [2]. LEACH assembles the nodes in the system into little bunch and desires individual of them as the cluster-head. Node primary wits its objective and after that sends the significant information to its cluster-head, afterward the cluster head combined and condense the information established from each and every node and mail it to the base location. The nodes selected as the cluster head draw off more energy as contrast to the further nodes as it is mandatory to mail data to the base location which may be distant positioned. Therefore LEACH uses arbitrary replacement of the nodes obligatory to be the cluster-heads to uniformly allocate energy consumption in the network.

In LEACH protocol, all the sensor nodes have the identical likelihood to be a cluster head. This characteristic leads to an unbiased allocation of the energy consumption to each and every one node and makes it feasible to have a longer life span in the network. A number of mechanisms have been conducted on the presentation and improvement of LEACH protocol. This work, recommend an improved version of Leach Protocol which intend at enhancing the throughput and performance using Neural network along with ACO and BCO.

2. LEACH Protocol

LEACH Protocol is a typical representative of hierarchical routing protocols. It is self-adaptive and self-organized. LEACH protocol uses round as unit, each round is made up of cluster set-up stage and steady-state stage, for the purpose of reducing unnecessary energy costs, the steady state stage must be much longer than the set-up stage [3]. If it happened that some nodes begin to die, the network operation may become unstable and unreliable data transferring will occur. Therefore, the longer the stable period is, the better the performance of the network. In LEACH Protocol, cluster heads are responsible not only for communicating with the base station, but for the data fusing. Randomly distributing the nodes and randomly selecting the cluster heads causes some cluster heads die earlier because of the low energy or

the long distance to base station. Secondary cluster heads are set for these clusters to be responsible for the communication with common nodes and data fusing; this balances the energy load of cluster heads and avoids premature death of these cluster heads, so the stable period of network lifetime will be prolonged. The LEACH protocol is divided into rounds and each round consists of two phases: the set-up and steady phases.

Setup phase: Each node decides independently if it will become a CH or not. [5] This election probability is based on the last time a node has been elected as a CH. The node that hasn't been a CH for long time is more likely to elect itself than other nodes that have been CHs recently [9]. In the setup phase, each CH inform their neighbor nodes with an advertisement message that it has become CH. Non-CH nodes choose the advertisement message with the strongest received signal strength. The member nodes then inform to the chosen CH that they have become a member of that cluster using a "join message" which contains their identifications. After this phase, the each CH knows the number of member nodes and their identifications. Based on the number of member nodes of the cluster, the each CH creates a TDMA schedule and broadcasts it to its cluster members. LEACH is a cluster-based protocol, which includes distributed cluster formation. LEACH randomly selects a few sensor nodes as cluster-heads and rotates this role to evenly distribute the energy load among the sensors in the network. In LEACH, the cluster-heads compress data arriving from nodes that belong to the respective cluster, and send an aggregated packet to the BS in order to reduce the amount of information that must be transmitted to the BS.

Steady phase: At the beginning of each round each node advertises it probability (depending upon the current energy level) to be the cluster head to all other nodes. Based on the received signal strength each non cluster head for this round (random selection with obstacle) chooses their cluster head. In LEACH protocol, time is divided into many rounds. In each round, all the nodes contend to be cluster head according to a predefined criterion in the steady data transmission phase. Member nodes in every cluster send data to their own cluster head. The cluster head compresses the data that received from member nodes and sends the compressed data to the sink node. [5] We suppose that the time of set-up phase is α and the steady data transmission time is t, then the time length of every round is $tr = \alpha + t$. The energy dissipation of the steady data transmission phase operation is broken into several frames.

3. Comparative Study

A lot of research work has been done in the contrast of LEACH protocol optimization in wireless sensor network. A. Christian and Dr. Himanshu Soni proposed an iLEACH Protocol for significant improvement in network lifetime and to achieve the minimal energy consumption and then compared the performances of iLEACH Protocol with LEACH Protocol in terms of network lifetime[4] whereas K. Pawar proposed their work on the basis of development of LEACH Protocol to additional progress its energy efficiency capabilities by bearing in mind the energy level of sensor nodes in the cluster head assortment method in diverse surroundings and also optimize it through genetic algorithm[6]. O. Zytoune present a Stochastic Low Energy Adaptive Clustering Hierarchy protocol (SLEACH), which outperforms the LEACH when the appealing unruffled data is the smallest amount or the highest value in a region [7].

4. Proposed Work

4.1 Initialization

We initialize the system using LEACH Protocol. Low Energy Adaptive Clustering Hierarchy (LEACH) is the first hierarchical cluster-based routing protocol for wireless sensor network which divides the nodes into clusters, in each cluster a devoted node with additional privileges called Cluster Head (CH) is accountable for creating and manipulating a TDMA (Time division multiple access) calendar and sending collective data from nodes to the BS where these data is required using CDMA (Code division multiple access). Remaining nodes are cluster members. This protocol is separated into rounds; every round consists of two phases;

Set-up Phase
(1) Advertisement Phase
(2) Cluster Set-up Phase
Steady Phase
(1) Schedule Creation
(2) Data Transmission

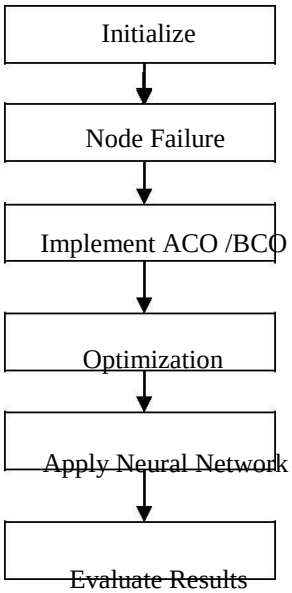

Figure 1: System Design

4.2 Apply ACO / BCO

Ant colony optimization algorithm is a proposed meta-heuristic approach for solving hard combinatorial optimization problems. ACO was inspired from the principle of pheromone trail lying and following behavior of real ants, which use pheromones as a communication source and medium. Analytically the biological example described the ACO algorithm behavior is related to the indirect contact of a colony of simple agents, called (artificial) ants, mediated by (artificial) pheromone trails. The pheromone trails in ACO same as distributed numerical information, which is used by the ants to probabilistically construct solutions for the given problem. Furthermore, this chemical substance is used by the ants to adapt the search process during the algorithm's execution to reflect their search experience.

BCO is the SI system where the low level agent to the system is the bee. BCO is the name given to the collective food foraging behavior of honey bee. The bee system is a standard example of organized team work, well coordinated interaction, coordination, labour division, simultaneous task performance, specialized individuals, and well-knit communication. In a typical bee colony there are different types of bees. There is a queen bee, many male drone bees and thousands of worker bees.

4.3 Apply Neural Network

With the appearance of microelectronics, as sensor nodes became cheaper, smaller and lower weight, their batteries became smaller too. The main and most important reason for Wireless Sensor Networks development was for continuous monitoring of environments where are difficult or impossible for human being to access or stay for a long time; Monitoring of environments like head of an active volcano, difficult terrain border lands, bridges, battlefields, roads, sluices etc. So, normally, there is often low possibility to replace or recharge the dead nodes as well.

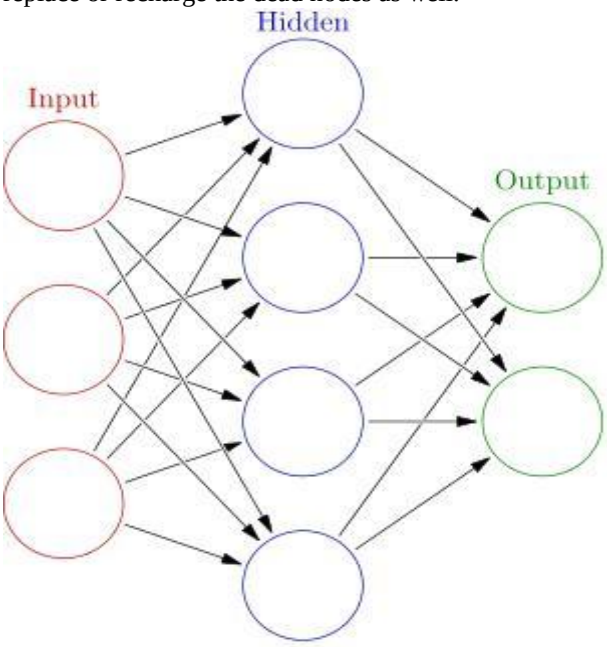

Figure 2: Neural Network

The other important requirement is that in most applications of WSNs, we need a continuous monitoring, so the lifetime and network coverage of these networks are our great concerns since the performance of WSNs severely depends on their lifetime. Therefore, energy conservation is a serious and critical issue in designing of WSNs with longevity. Energy conservation should be gained by wisely management of energy resources. The first step to reduce the energy consumption of WSNs is to know the most energy consuming parts of these networks which are important in choosing the appropriate method. Energy consumption of communication subsystem is much more than that of computation subsystem. Recently there is a strong interest to use intelligent tools such a Neural Network in energy efficient methods of Wireless Sensor Networks. Artificial Neural Networks are arithmetic algorithms which are able to learn complicated mapping between input and output according to supervised training or they can classify input data in an unsupervised manner. Some

of the algorithms developed within the classical artificial neural networks, can be easily adopted to wireless sensor network platforms and in the same time they can meet the requirements for sensor networks like: simple parallel distributed computation, distributed storage, data robustness and auto-classification of sensor readings, fault tolerance and low computation. The other important motivation to use neural network based methods in WSNs is the analogy between WSNs and ANNs. It is strongly believe that ANNs exhibit exactly the same architecture as WSNs since neurons correspond to sensor nodes and connections correspond to radio links. In fact, Neural Networks are not energy conservation methods and cannot independently help to conserve energy but they can help energy conservation methods as intelligent tools to work in more efficient, desirable and easier way.

5. Methodology

5.1 Implementation of BCO-NN algorithm

1. Initialization
2. For every bee (E) do the forward pass
    a) Set b=1
    b) Find all likelihood moves
    c) Choose only one move on basis of wheel
    d) B=b+1
3. Backward pass starts
4. Distinguish the bees on basis of their objective
5. Choose whether to continue or not, else follow
6. For each follower choose new method
7. If there is no halt then GO TO step 2
8. Output will be the best value
9. Apply Neural Network
10. Evaluate metrices values i.e. throughput and energy consumption.

5.2 Implementation of ACO-NN Algorithm

1. Initialization
2. Each and every ant is in arbitrary area
3. For each ant choose next area
4. Continue to visit new areas
5. Return to initial area
6. Update pheromone level

7. Output will be best result
8. Apply Neural Network
9. Evaluate metrices values i.e. throughput and energy consumption

6. Results

In this section results are presented that explore the relationship between various system parameters and the network lifetime. The result values are shown in the table 1.

Table 1: Results Table

Parameters	ACO-NN	BCO-NN
Throughput	84%	93%
Energy Consumption	300 J	200 J

The table shows the comparison between ACO and BCO parameters in terms of throughput and energy consumption.

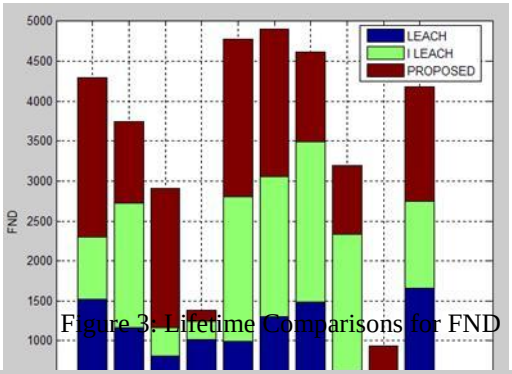

Figure 3: Lifetime Comparisons for FND

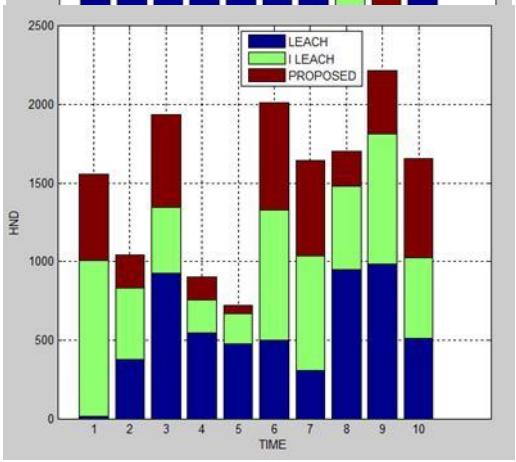

Figure 4: Lifetime Comparisons for HND

Fig.3 shows that the first node dies later in the proposed scheme. It also indicates that in proposed scheme all nodes remain alive for more rounds compared to the first node dies earlier in the previous schemes. In this way, this extends the lifetime of network. Fig.4 also illustrates the more network lifetime in proposed scheme which is indicated by Half Node Dead.

The second: Energy consumption of BCO Algorithm based on Neural –Network is less than the Energy consumption of ACO-NN.

That mean the new combination of BCO-NN outperforms than the ACO-NN algorithm.

More over in this approach we used the custom BCO network for the enhancement where as there is a lot of other methods of BCO network which can be used for this proceeding like BPA, BFA.

7. Conclusion and Future Scope

In this paper we considered a well-known protocol for wireless sensor networks called LEACH protocol which is the primary and the most imperative protocol in wsn which uses cluster based propagation technique. Followed by an overview of LEACH protocol implementations, then we proposed a fusion of LEACH protocol involving ACO and BCO based on neural networks. By using FND and HND metrics, the comparison of the performances of the proposed protocol with the previous schemes has been evaluated. From the simulation results, we can illustrate a number of conclusions.

The first: Throughput of BCO Algorithm based on Neural – Network is more than the throughput of ACO-NN.

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